

PATENT SPECIFICATION

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(54) PROCESS FOR REDUCING THE PRODUCTION OF EXCESS SLUDGE IN ACTIVATED SLUDGE PLANTS FOR THE PURIFICATION OF WASTEWATER

(71) We, FARBWERKE HOECHST AKTIENGESELLSCHAFT, vormals Meister Lucius & Brüning, a Body Corporate recognised under German Law, of 6230 Frankfurt (M)-Hoechst, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a process for reducing the production of excess sludge caused by the assimilation metabolism of sludge bacteria in activated sludge plants for the purification of waste water.

For the purification of municipal and industrial waste water biological processes have been gaining importance. Relatively large amounts of waste water have been purified by the so-called activated sludge process according to which the untreated water is first mechanically preclarified and is then introduced into an activated sludge or aeration basin where the organic substances dissolved in the wastewater are decomposed by bacteria. In a second basin, the purified water flowing into the receiving water is separated from the sludge, the major part of which is returned to the aeration basin by a pump.

The biological purification is based, on the one hand on the dissimilation metabolism of the bacteria, which yields carbon dioxide and water as end products, and, on the other hand, on the assimilation metabolism of the bacteria in which part of the organic material is accumulated in the bacterial cell or used for building up new body substance. The dry substance of the sludge is increased by the assimilation metabolism. This "excess activated sludge" is removed from the aeration basin, thickened, drained and finally deposited in a dumping place or incinerated.

The sludge is drained either in drying beds, which requires considerable areas of field, or by centrifuging or filtration on filter presses or suction filters.

When rotary filters are used for sludge draining, as is usually done in industry, a flocculation agent must be added to the sludge, 1 kg of dry substance requiring about 1 kg of lime and 200 g of iron sulphate. Waste water from chemical plants having a biochemical oxygen demand (BOD₅) of 1 to 1.5 g of O₂ per litre yields, for each cubic metre, about 21 l of sludge having a solids content of about 3%. The deposition in dump-places of sludge drained to a residual water content of 75 to 80% requires pits which are protected against the contamination of ground water and furthermore involves considerable transportation problems, while the incineration of the sludge necessitates special furnaces and an additional expenditure of energy. The incineration is in general more expensive than the deposition in dump-places.

To prevent or at least reduce the production of excess sludge, the following two possibilities have hitherto been proposed:

(1) The activated sludge is only partially charged with organic impurities, i.e. the aeration time is prolonged relative to that of more highly charged plants. In this case, accumulated substances and part of the cellular substance of the bacteria are consumed by respiration.

(2) In the so-called separated sludge stabilisation, the excess sludge is further aerated in separate basins for several days.

In both these processes, relatively large or additional basins are needed, which is often impracticable for lack of space and also involves high costs of construction.

The present invention provides a process for reducing the production of excess sludge in the operation of an activated sludge plant for the purification of waste water, which comprises carrying out the biological decomposition of impurities contained in the waste water by sludge bacteria of the plant in the presence of a bacteriostatically effective amount of a disinfectant.

[Price 5s. 0d. (25p)]

As disinfectants, phenol, particularly nitrophenols, have proved advantageous in bacteriostatically effective concentrations. Other disinfectants which may advantageously be used in bacteriostatically effective concentrations to reduce the production of excess sludge are soluble cyanides, tin compounds which have been proposed for use as pesticides, for example triphenyl-tin acetate, and mycelium refuse obtained in the manufacture of antibiotics.

The exact amount of disinfectant to be used must be determined in each case by a test since it depends to a certain extent on the composition of the waste water.

It is possible that the sludge bacteria may become resistant to a specific disinfectant after some time and it is therefore recommended that the disinfectant is replaced from time to time by another disinfectant.

Phenols and cyanide have proved particularly advantageous. Other bacteriostatically effective disinfectants may, however, also be used. The production of excess sludge can be reduced, for example, by the addition of aromatic hydrocarbons such as toluene. Relatively large amounts of these aromatic hydrocarbons are, however, needed so that their use may be disadvantageous in special cases for reasons of cost.

It has already been proposed to use disinfectants, advantageously chlorine, as auxiliary agents in biological sewage purification plants to prevent disturbances due to overcharging. In this case the disinfectants have been used for the destruction of troublesome microorganisms, particularly filamentous bacteria which give rise to the formation of bulking sludge.

It has also been proposed that life in biological purification plants is impeded by the presence of copper salts, the fungicidal action of which has been known for some time.

We have found, however, that such disinfectants which normally interfere with the working of the plant reduce the production of excess sludge without affecting the rate of decomposition, of they are used in an appropriate, i.e. a bacteriostatically effective, concentration.

The following Examples illustrate the invention.

In the Examples, the tests were carried out in activated sludge installations on a laboratory scale, using an aeration volume of 3.5 litres. The apparatus operated according to the same principle as industrial plants for the biological purification of waste water. As the waste water to be purified, there was used effluent from petrochemical plants and from the production of plastics and solvents, having a biochemical oxygen demand, BOD_5 , within the range from 500 to 1500 mg/l.

Besides the plant containing the individual

additions, a comparison plant was operated without any addition but otherwise under the same conditions, which were; time of aeration 9 hours, 50 litres of compressed air/hour, 200% return sludge, 3.5 g of dry solid matter of activated sludge per litre, 130 mg of a mixture of ammonium nitrate and phosphate containing 20% N and 20% P_2O_5 per litre of crude water serving as supplementary nutriment for the bacteria.

EXAMPLE 1

Disinfectant tested: toluene

Addition: 1 ml/l of wastewater

Duration of test: 33 days

Result: The production of excess sludge was reduced by 26%, the rate of decomposition being the same as in the comparison plant.

EXAMPLE 2

Disinfectant tested: 2,4-dinitrophenol (DNP)

Addition: 5 mg/l of wastewater. As the substance is insoluble in water in the acid range, the crude water had to be rendered weakly alkaline.

Duration of test: 38 days

Result: The rates of decomposition of BOD_5 and COD (chemical oxygen demand) were about the same in both plants. The production of excess sludge in the test plant which was about 190 g of dry solid matter/kg of decomposed BOD_5 , was about 20% lower than that of the comparison plant.

By increasing the addition from 5 to 10 mg of DNP per litre of wastewater, (duration of test 26 days), no further reduction of the production of excess sludge was obtained. 1 mg/l was ineffective. When the toxicity of DNP to anaerobic bacteria was tested, the DNP has a threshold toxicity of 1 mg/l. The threshold toxicity to fish is about 20 mg/l according to Grindley (Liebmann, *Handbuch der Frischwasser- und Abwasserbiologie* II, 1946). The effluent of the test plant was innoxious to goldfish when diluted at a ratio of 1:1 was drinking water. Hence there is no danger of a detrimental effect on higher or lower river organisms.

EXAMPLE 3

Disinfectant tested: Potassium cyanide (KCN)

Addition: 2 mg KCN/l of waste water

Duration of test: 49 days

Result: The production of excess sludge which was 215 g/kg of decomposed BOD_5 was on an average 23% lower than that of the comparison plant, the rates of decomposition of BOD_5 and COD being the same or being temporarily somewhat improved in the test plant. In both plants, the sludge settled well. The effluent of the test plant was distinctly clear owing to a smaller number of dead bacteria.

In a second test using additions of 1 and 2 mg, respectively, of KCN/l the production of excess sludge was reduced by 20% and 30%, respectively.

- 5 When the toxicity of KCN to anaerobic bacteria was tested, the KCN had a threshold toxicity of 1 mg KCN per litre. As threshold toxicity to fish 0.03 to 0.25 mg KCN per litre has been indicated (cf. Liebmann, *Handbuch der Frischwasser- und Abwasserbiologie* II).
- 10 The effluent of the test plant, having a residual CN content of 0.05 mg/l was tolerated by goldfish without any symptoms. Hence, even sensible water organisms would
- 15 not be endangered.

EXAMPLE 4

Disinfectant tested: triphenyl- tin acetate
Addition: 50 mg/l wastewater
Duration of test: 31 days

- 20 Result: The rates of decomposition were the same as those of the comparison plant. The production of excess sludge was reduced by 18%. Additionally, the depositing properties of the sludge were considerably improved. This enabled higher concentrations of
- 25 sludge to be kept in the aeration basin, which secondarily resulted in a reduction of the production of excess sludge.

EXAMPLE 5

- 30 Disinfectant tested: Refuse of compressed tetracycline mycelium
Addition: 300 mg of humid mycelium (corresponding to about 500 IE tetracycline) per litre of waste water.

- 35 Duration of test: 34 days
Result: The production of excess sludge was reduced by 25%, the rate of decomposition being the same. When only 150 mg/l were used, no effect was obtained. Refuse of
- 40 penicillin mycelium was used with similar success.

- The costs of the sludge reduction in accordance with the invention amount to about one third of the saving in the operating
- 45 cost when the amount of sludge to be drained and removed was reduced by 20%. The costs of the process of the invention can be reduced by using, instead of the commercial products, waste water or refuse which already contains

the substances to be used in accordance with the invention. For example, dinitrophenol is obtained in the manufacture of certain alizarin dyestuffs and cyanogen compounds are contained in the waste water of galvanization plants.

The process of the invention has the advantage that with lower cost of filtering equipment and lower consumption of filtering auxiliary agent the activated sludge plant can be charged to the same extent as a plant operated without additives for the reduction of sludge. The storage and dissolution of the chemicals as well as the metering-in of the solutions can be carried out without technical difficulties.

WHAT WE CLAIM IS:—

1. A process for reducing the formation of excess sludge in the operation of an activated sludge plant for the purification of waste water, which comprises carrying out the biological decomposition of impurities contained in the waste water by the sludge bacteria of the plant in the presence of a bacteriostatically effective concentration of a disinfectant.
2. A process as claimed in claim 1 wherein a phenol is used as disinfectant in a bacteriostatically effective amount.
3. A process as claimed in claim 2 wherein the disinfectant is a nitrophenol.
4. A process as claimed in claim 1 wherein the disinfectant is a soluble cyanide.
5. A process as claimed in claim 1 wherein the disinfectant is an organotin compound.
6. A process as claimed in claim 1 wherein mycelium refuse from the manufacture of antibiotics is used as the disinfectant.
7. A process as claimed in any one of claims 1 to 6, wherein the disinfectant is replaced from time to time by another disinfectant.
8. A process as claimed in claim 1, conducted substantially as described in any one of the Examples herein.

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